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THE IMPACT OF TECHNOLOGICAL DEVELOPMENT ON THE OUTPUT OFTHE INDUSTRIAL SECTOR IN SAUDI ARABIA

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ABSTRACT

This research aims to measure technological development and shows its impact on the growth and development industrial production in Saudi Arabia from 1981 to 2018. The research is based on data issued by the Department Statistics and Information in Saudi Arabia. The descriptive approach was used to explain the technological developm and other variables, and a standard approach was used to measure the impact of the level of technological developm and spending on workers, and the value of capital on the outputs of the industrial sector in the region. Saudi Ara during the research period using the well-known Cup Douglas function, and technological development was extrac using the Solo model. The standard approach was used through the ARDL model to determine the impact of each of technological development, and industrial labor spending that represents (compensation of workers in the indust sector), and industrial capital spending which represents (assets purchased in the industrial sector) on the output of industrial sector.The results showed a significant relationship between the variables and this means exist a long- equilibrium relationship. The results also revealed a positive and significant impact of technological development on output of the industrial sector in Saudi Arabia.

KEYWORDS: Technological Development, Industrial Sector Outputs, Industrial Labor Spending, Industrial Cap Spending, Cup Douglas & ARDL

Original Article

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1.1 INTRODUCTION

Technological development is one of the most important factors affecting production in any industry, as the correct use of technology has become the basis for most of the developments witnessed by modern industries in all their sectors and stages of growth.Economists, most notably Solo 1956, were interested in the importance of technological development as an external and essential variable in bringing about high growth rates for capitalist economies through its effect on the production function represented by: the two elements of capital and labor (Al-Khulaqi, 2012).

Because of our sense of the importance of the industrial sector and it role in economic development in economic development by providing manufactured materials, limiting imports and increasing exports. We had to look into possible ways and means to develop this sector. Since development is only achieved by providing a scientific, knowledge, skills and experience base for individuals (Mohammed,2007).On the other hand, the industrial sector is one of the most important pillars on which economic and social development in Saudi Arabia is based. It has received great attention from the state since the beginning of the development plans in 1970(VISION, 2030).

1.2. Research Importance

The improvement in the ability of developed countries to obtain huge levels of productivity at low costs is due to their use of advanced technology levels. Which makes them able to compete in global markets, while the productivity of developing countries decreases and loses their ability to compete in global markets for using levels of technology that are not developed or inappropriate to usein developing countries.Hence the importance of research in knowing the impact of technological development on the output of the industrial sector in Saudi Arabia.

1.3. Research Problem

The continuous technological development in the various manufacturing industries leads to viral changes in the productivity of those industries in various developed countries.And the technological levels in use that are adequate with the production structures in the developed countries may not be adequate with the production structures in the developing countries, considering Saudi Arabia as one of the developing countries in terms of production factors. This research seeks to measure the impact of technological development used on the output of the industrial sector.

1.4. Objective of the Study

This research aims to measure technological development and shows its impact on the growth and development of industrial output in Saudi Arabia during the research period (1981-2018).

1.5. Research Hypothesis

In light of economic theory, this research tests the main hypothesis that confirms that the growth of total industrial output depends mainly on the growth of technological development used in the production process through increasing the efficiency of productivity of the production factors. The research also assumes the positive effect of both capital and labor on industrial output in Saudi Arabia, and the assumption that the industrial production function is homogeneous of the first degree.

2. LITERATURE REVIEW

There are many studies that have discussed the impact of technological development on the output of the industrial sector whether in Saudi Arabia or in some other Arab or foreign countries. In this part of the research, we will review the most important of those studies with the aim of identifying the most important results that have been reached.

Lamineand Benlahbib's (2020) study aimed to measure the impact of ICT on economic growth in Arab countries through a standard study that included cross-sectional data for 18 Arab countries during the year 2018.Based on the independent variables represented in: the percentage of subscribers to the Internet service, the percentage of mobile phone subscribers for every 100 people, the percentage of fixed phone subscribers for every 100 people, in addition to the economic growth expressed as the average per capita GDP as a dependent variable, and by relying on the technique of statistical analysis represented by the cluster analysis. The Arab countries were classified into three groups according to the information and communication technology index, and the Gulf countries were at the forefront. The method of residual regression analysis was used, which concluded in the end that the variable of Internet subscribers was the only effect on the economic growth of the Arab countries. The study of Othman (2017)aimed at both monitoring the impact of integrating scientific research and technological development on knowledge-based development and measuring the impact of the knowledge and technology progress indicator on the gross domestic product. Through analysing and reviewing the reality

of the economic and social plans of Egypt during (1998 - 2012). The researcher concluded that the successive economic and social plans of the state were not effectively and comprehensively integrated into the scientific research and technological development in the development process; which means that scientific research and technological development have not contributed to the positive development of the Egyptian national economy.EL-nawawy & Morshedy(2017) in his research that aimed at presenting the emerging ICT industries in two countries, he concluded that Egypt's ICT's Gross Domestic Product (GDP) contribution grew by13% in 2014-15 to reach 4.1%, while India is expected to contribute 9.5% of India's Gross Domestic Product (GDP) in 2015-16. Al-Jabri's (2016) study aimed to estimate production functions using the Cup-Douglas function of production for large Iraqi industrial companies and to demonstrate the extent of the contribution of each of the independent variables represented by the number of workers, wages, salaries and the value of production requirements on the dependent variable. The value of production represented by the Added Value according to the hypothesis claims that the independent variables have a significant effect on the dependent variable. The researcher also used the SPSS statistical program to analyse the results. The most important finding of the researcher is that the Cup-Douglas function is the best function to represent the productive process of large industrial companies from an economic point of view. The contribution of the value of production inputs was more than the contribution of the number of workers, wages and salaries to the production function, while the contribution of the value of production inputs to the added value was more than the contribution of the number of employed, while the contribution of wages and salaries to the added value was more than the contribution of the value of production inputs to the production function. The study of Lewrick, et al.(2014) assessed and explored the sources of productivity growth in the industry represented by internal specialization of the industry, reallocation of internal resources in heterogeneous industries, and technological progress; and the data extracted from the Swiss industries market during (1997-2009), that show how the framework used in the study was practically applied. The researchers also used the greatest impact model on the overall productivity using the internal weighted average of the overall productivity of the firm. They also concluded that the source of reallocated internal inputs in heterogeneous industry has a major effect on the overall production. The effect of internal specialization in industries and technological advancement has less effect on productivity in Swiss industries.The study of Yan and Chien (2013) aimed to evaluate the effectiveness of high-tech development and national economic policies for energy use based on real data from an industrial complex in Taiwan. The researchers used the input-output analysis method to clarify the positive effects of scientific complexes on economic and industrial development. The concept of energy intensity and the energy saving index has been applied to assess the relationship between economic growth and energy consumption, where the implications of three energy policies were studied. First, high-tech industries should be considered as part of the national and regional economy by the government. Second, an appropriate industrial assembly mechanism and government-supported joint environmental facilities can improve energy efficiency in high-tech industries. Third, government policies using the tax and management system in scientific complexes directly affect energy consumption in high-tech industries. The researchers concluded that the goals of economic efficiency and energy could be achieved together through the development of high-tech industries. Al-Marzouki's(2013)study aimed at observing the relationship between the size of the industrial establishment, measured by the paid-up capital, and the characteristics of industrial companies, such as the elasticity of productivity in relation to the elements of production and the factor of productive efficiency, that measures the technological level (in light of the size of a certain paid capital), and the constant substitution elasticity between production elements and other renewed features of industrial companies in Saudi Arabia through a sample of 54 companies in the Saudi Industrial Sector for a period of two years (2008-2009). The researcher used the

cross-sectional time series approach by applying three models: Pooled Regression Model (PRM), the fixed effects model (FEM), and the random effects model (REM) on the Constant Elasticity of Substitution Production Function (CES). The regression of real production (sales value) was estimated on the explanatory variables of labour (Number of workers), and capital (machines and equipment used in the production process after subtracting depreciation) through three stages. The most important finding of the researcher is that the size of the company affects technological progress, as the values of technological progress change according to the size of the company; the larger the company, the greater the estimated value of technological progress. The study of Al-Khallaqi (2012) assessed the impact and role of technological progress on economic growth in Saudi Arabia. The researcher used the Foreign Trade Index in technology as an indicator to indicate the technological progress for the period (1969-2008), and by using the joint integration approach on the logarithm of the variables to estimate the Cup-Douglas function. The study found that the technological progress factor was not significant in the short and long terms. Zaman and Goschin (2010) used two different models for the Cup-Douglas function to study the test of technological progress in the theory of internal and external growth in Romania for the period (1990-2007). In the first model, technological progress was an internal variable and the other model was an external one, and the results found that the role of technological progress on the growth of the GDP was reduced due to reasons such as the weakness of the general government policy in the long term. The decrease in the number of workers in research and development, and the weak cooperation with international organizations and the scientific community.Al-Marzouki's study (2009) aimed to know the impact of technology development on economic growth in Saudi Arabia. The dynamic comprehensive equilibrium model that simulates the reality of the economy was used and after feeding the model with the necessary data, the model was initiated to cover the period (1999-2012). It was observed that all results supported the importance of technical development. Zhao and Honggang (2008) used the production function to estimate the economic growth of China for the period (1978-2002), and compared the results of the estimate with that of Japan.The researchers concluded that the growth rate of the GDP in China was growing at an annual rate (9.5%) wherein the largest share of the labour contribution was at an annual growth rate (4%), followed by the contribution of technological progress at an annual growth rate (3.8%), and finally, the contribution of capital was at an annual growth rate (1.7%).Muhammad’s (2007) study aimed to measure the impact of technological development on the output of the Iraqi industrial sector for the period (1970-1990). The researcher used multiple regression analysis and theOrdinary Least Squares (OLS). The researcher concluded that technological development positively affects the Iraqi industrial output in a very small amount and that the industrial sector works in a stage of diminishing of scale returns. As for the rate of participation of production elements in the production process, the study showed that the rate of capital participation in production was less than the rate of labour participation, and that technological development was more intensive in work at the expense of the capital. In their study, Busse and Groizard (2007) studied technical trade in economic development using the two-stage least-squares estimation for twenty-one countries through the Commodity Import Classification Index to find out to what extent the high concentration of importing goods impact in research and development is on economic growth. The study concluded technology imports have a positive and statistically significant effect at the level of 10%.The researcher Raies (2006) assessed the impact of technological change and the industrial structure on the efficiency of industrial growth and the formation of the theoretical framework in order to explore the various sources of industrial growth efficiency and to identify the variables explaining the efficiency. The efficiency of the internal facility has a strong impact on industrial efficiency.The study of Al-Gharib (2006) aimed to identify the most important determinants of the productivity of both labour and capital in the manufacturing sector in Saudi Arabia during the period (1970-2004). The researcher used the standard approach to

estimate the Cup-Douglas function. The study found that the main factors affecting average labour productivity are the Industrial Development Fund loans, the level of technology, and the degree of economic openness. This study also found that the most important factor affecting the average productivity of capital is the rate of inflation prevailing in the Saudi economy.Canaan (2005), his study was on technological progress in light of globalization and its effects on economic growth in developing countries (a study on Asian industries), concluded that technological specialization determines export success, and that capital accumulation is important, but it needs to be supplemented with the ability to learn and simulate and to innovate in all fields. Besides, technological progress requires us to live and interact with it so that we can use it within the cultural, social, and other desirable measures in the country.The studyof Perrin (1997) aimed to evaluate the impact of technological change in analytical terms on the input and output market in the competitive industry. The researcher used comparative data dependant on local asymptotic equations on both the technology level and industrious level in that technology. The researcher found that the model used could measure the impact of technological development on the previous and subsequent competitive industry, as well as the interaction of market flexibility with changes in technology in order to determine the benefits of new technology. In his study,Ayoub and Diab (1991) aimed to find out the role that technical change played in the growth of the cement industry in Saudi Arabia in the period (1961-1987) by using the Cup-Douglas function $Y = (Ae^{zt}) K^{a}L^{b}$ to estimate the parameters of productivity and technical change factors. By using the least squares method, it was found that the transcendental function of production model gives the best results to explain technical change and productivity in the Saudi cement industry. Aukrust (1965) alone, using the Cup-Douglas function for the period (1949-1959), estimated the production functions for ten countries; namely, Belgium, Canada, the Netherlands, Norway, Sweden, the United Kingdom, France, Italy, Germany, and Japan. He found that the highest change in the level of technological progress was in Germany, where it was growing at an annual growth rate (5.6%) in the first period (1950-1954), and that the least change in the level of technological progress was in Canada, where it was growing at an annual rate (0.7%) for the whole period of (1949-1959). Together, Aukrust and BjerkeK (1959) used the Cup-Douglas function in logarithmic form to estimate the total production function for Norway, excluding the period of World War II for two periods, the first (1900-1939), and the second (1950-1956). They concluded that economic growth in Norway occurred as a result of an increase in employment at an annual rate (0.46%), the increase in the volume of physicalcapital was growing at an annual rate (1.12%), and that the development of technology was also growing at an annual rate (1.8%). All previous studies have shown the positive effect of technological development on economic growth in general and in particular on industrial output in various Arab and foreign countries, and from this standpoint, this research will measure the impact of technological development on the output of the industrial sector in Saudi Arabia.

3.1. RESEARCH METHODOLOGY

To achieve the objective of this research, we use the ARDL model to find out the extent of a Co-integration relationship by estimating the long-term and short-term relationships after making sure that there are no standard problems in the model and all conditions are fulfilled.E-Views 9 will be used to analyse the data.

To find out the effect of technological development on the output of the industrial sector in Saudi Arabia during (1981-2018), this research will consist of a dependent variable and three independent variables, by using the well-known Cup-Douglas function:

$$Q = T.L^{\alpha}K^{(1-\alpha)} \ldots \quad \ldots.(4-1)$$

Where:

Q: is the value of industrial output at current prices

T: the level of technological development

L: Expenditure on workers (workers compensation)

K: Industrial capital (purchase assets)

α, (α-1) : production elasticities with respect to labor and capital

To verify the hypotheses that were previously laid down in this research, the standard model will be estimated from the previous mathematical model (1), and converted to logarithm using the following steps:

$$Log(Q) = Log(A.T.L^{\alpha}K^{(1-\alpha)}) \ldots\ldots(4-2)$$

$$Log(Q) = Log(A) + Log(T) + Log(L^{\alpha}) + Log(K^{(1-\alpha)}) \ldots\ldots(4-3)$$

$$Log(Q) = Log(A) + Log(T) + \alpha\, Log(L) + (1-\alpha)Log(K) \ldots.(4-4)$$

The econometric model can be formulated as follows:

$$\mathrm{Log\ Q_t} = Log(A) + \mathrm{Log\ T_t} + \alpha\ \mathrm{Log\ L}_t + (1-\alpha)\ \mathrm{Log\ K_t} + \varepsilon_{\mathrm{t}} \ldots(4-5)$$

ε_t :the random variable

A: Cutter.

To calculate the level of technological development by taking the growth rates on both sides of equation (4) as follows:

$$\frac{dLog(Q)}{dt} = \frac{dLog(T)}{dt} + \alpha\frac{dLog(L)}{dt} + (1-\alpha)\frac{dLog(K)}{dt} \ldots\ldots(4-6)$$

$$\frac{dLog(T)}{dt} = \frac{dLog(Q)}{dt} - \alpha\frac{dLog(L)}{dt} - (1-\alpha)\frac{dLog(K)}{dt} \ldots\ldots(4-7)$$

$$\Delta T = \Delta Q - \alpha\,\Delta L - (1-\alpha)\Delta K \ldots\ldots(4-8)$$

3.2. The Description of the Variables

3.2.1. Technological Development (T)

The previous studies of technological development emphasized the great importance of this variable which stems from the role it plays as one of the main determinants of industrial production in Saudi Arabia, which is what Al-Marzouki's (2009) concluded. The technological development of Saudi Arabia can be measured in this research using Solo's theory of growth 1957 using the residual, where the rate of growth of technological development can be obtained through the rate of growth of industrial domestic product in the manufacturing industries minus the rate of elemental contribution in the manufacturing industries.

3.2.2. Industrial Output (Q)

The contributions of industrial output are among the most important factors on which development in any economy depends, and industrial output is represented in this research resulting from oil refining and other industries.

3.2.3. Labor (L)

Labor component is an important factor of production in any industry. Solow pointed out in his theory of economic growth that technological development increases the rate of economic growth. Technological development is more effective when workers are able to use this technology, and from here we find the importance of trained workers in the use of technology, and the work component in this research is the compensation of workers (salaries, wages, benefits, and additional allowances)

3.2.4. Capital (K)

The capital is linked with the technological level in the industrial sector. That is, the more capital invested, the more this industry becomes able to use new and advanced technology. Therefore, we find the capital component in the use of advanced technology. The capital component in this research is represented by the value of productive fixed assets (such as residential and non-residential buildings, means of transportation, machinery and equipment, furniture, livestock, trees, and intellectual property products) and non-productive (land, studies and research, mineral discoveries, leases, licenses and goodwill).

3.3. RESULTS AND DISCUSSION

3.3.1 Draw the Time Series

We notice through the charts below the stability of the time series of the growth rates of the dependent variable and the independent variables at the level, that is meaning that they are integrated of degree I(0) as follows:

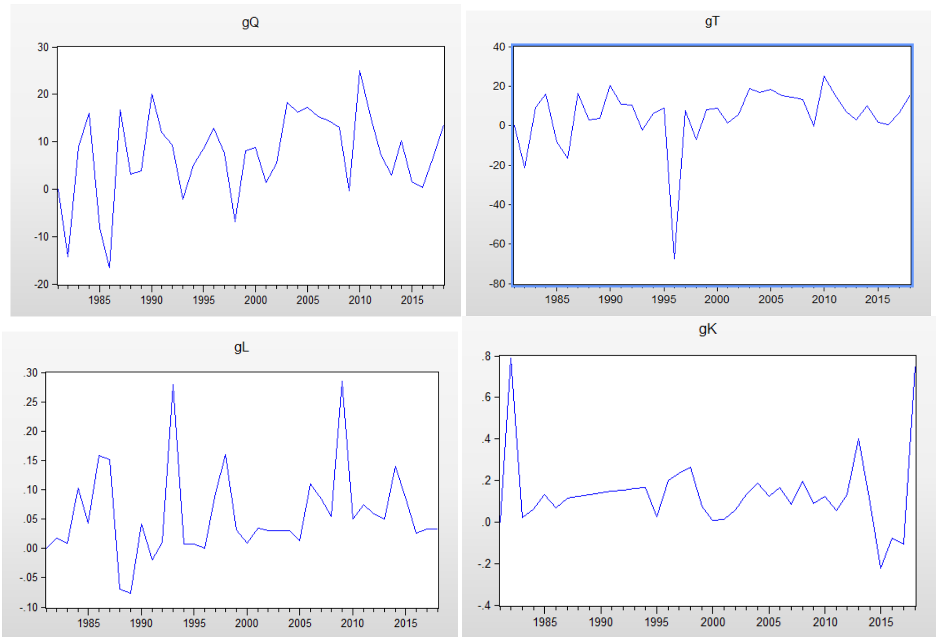

Figure 1: Graph to Study the Static of the Variables.

3.3.2. The Unit Root Test

To illustrate the stability of the series and its being free from the unit root, we use the Dickey Fuller test, which shows that the variables are constant at the level and at a significant 5% level. Thus, the Self-Regression Distributed Lag (ARDL) model can be applied.

Table 1: Static Test Results using the ADF

Values of t-Statistic using Unit Root Test and Prob				
	variable	**Intercept**	**Trend and Intercept**	**None**
Level	**GQ**	**-5.09**	-5.37	-3.41
		0.0002	0.0005	0.0012
	GT	**-5.75**	-6.02	-5.27
		0.0000	0.0001	0.0000
	GL	**-5.71**	-5.71	-3.91
		0.0000	0.0002	0.0003
	GK	**-5.16**	-5.53	-1.33
		0.0002	0.0004	0.1649
Critical Values forT Test				
Level of Morale		**Intercept**	**Trend and Intercept**	**None**
1%		-3.62	-4.22	-2.62
5%		**-2.94**	-3.53	-1.95
10%		-2.61	-3.20	-1.61

3.3.3. Optimal Lags Length

The number of optimal lags for an ARDL model was determined using Akaike info criterion and Hannan-Quinn criterion that give the lowest parameter value. From the results, we notice that the best chosen model is ARDL (1, 0, 0, 0).

Table 2: Optimal Lags Length

Model	LOGL	AIC*	BIC	HQ	Adj. R-sq	Specification
54	-120.871957	6.992886	7.212820	7.069649	0.233779	ARDL(1, 0, 0, 0)
27	-120.198520	7.011029	7.274949	7.103144	0.237314	ARDL(2, 0, 0, 0)
52	-119.809742	7.044986	7.352892	7.152453	0.227873	ARDL(1, 0, 0, 2)
45	-120.854551	7.047475	7.311395	7.139590	0.209004	ARDL(1, 1, 0, 0)
51	-120.867204	7.048178	7.312098	7.140293	0.208448	ARDL(1, 0, 1, 0)
53	-120.868055	7.048225	7.312145	7.140340	0.208410	ARDL(1, 0, 0, 1)

3.3.4. The ARDL Model

We notice from the test results that the value of the adjusted corrected determination coefficient R^2 reached (27%).Which means that (27%) of the changes in the dependent variable are due to the influence of the variables included in the model, namely: (technological development, spending on laborers, industrial capital), (73%) of the changes are due to other variables that were not entered into the model. (F) Test was significant for the model as a whole at (5%) level. The number of typical retarders is improved with Akaike standard, ARDL (1,0,0,0).

Table 3: ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GQ(-1)	0.107996	0.142673	0.756947	0.4546
GT	0.302676	0.084607	3.577441	0.0011
GL	-25.14374	17.17840	-1.463683	0.1530
GK	-3.465951	7.163881	-0.483809	0.6318
C	7.097751	2.264983	3.133688	0.0037

R-squared	0.350707	Mean dependent var	7.474964
Adjusted R-squared	0.269545	S.D. dependent var	9.202324
S.E. of regression	7.864917	Akaike info criterion	7.087789
Sum squared resid	1979.421	Schwarz criterion	7.305481
Log likelihood	-126.1241	Hannan-Quinn criter.	7.164536
F-statistic	4.321094	Durbin-Watson stat	1.967173
Prob(F-statistic)	0.006597		

3.3.5 Co-Integration Test

We notice through this test that the value of F-statistic (6.17) is greater than the tabular value (3.23) at a significant level (5%). This means that there is a long-run co-integration relationship between the dependent variable and the independent variables.

Table 4: Co-Integration Test

Test Statistic	Value	k
F-statistic	6.172745	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

3.3.6. The Results of the Relationship Are Short and Long Term

Through the results of the analysis of the model and assuming the constancy of other factors, the results were as follows:

Table 5: The Results of the Long and Short-Run Relationship

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GT)	0.302676	0.084607	3.577441	0.0011
D(GL)	-25.143740	17.178403	-1.463683	0.1530
D(GK)	-3.465951	7.163881	-0.483809	0.6318
CointEq(-1)	-0.892004	0.142673	-6.252084	0.0000

Cointeq = GQ - (0.3393*GT -28.1879*GL -3.8856*GK + 7.9571)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GT	0.339321	0.105443	3.218052	0.0030
GL	-28.187921	19.656670	-1.434013	0.1613
GK	-3.885577	8.078762	-0.480962	0.6338
C	7.957084	2.302777	3.455429	0.0016

3.3.6.1. Results of a Long-Run Relationship

- An increase in technological change (GT) by a unit leads to an increase in output in the industrial sector (GQ) by (0.33), and the relationship between them is positive and significant.

- An increase in spending on industrial laborers (GL) by one unit leads to an increase in the output in the industrial sector (GQ) by (-28.18), and the relationship between them is negative and not significant.
- An increase in industrial capital spending (GK) by one unit leads to an increase in the output in the industrial sector (GQ) by (-3.88), and the relationship between them is negative and not significant.

3.3.6.2.Results of a Short-Run Relationship

It was found that there is a positive and significant relationship between the output of the industrial sector and technological development (GT), and a negative and non-significant relationship between the output of the industrial sector and both spending on industrial workers (GL) and spending on industrial capital (GK). We also note that the value of the error correction factor (CointEq- 1) was (-0.89), which is a negative and significant value at (5%). This indicates the existence of a valid joint integration relationship, and that the deviations in the short time period are corrected with (-0.89) to reach a long-term equilibrium relationship.

4. CONCLUSIONS

The present research aims to measure the impact of technological development on the output of the industrial sector in Saudi Arabia during (1981-2018). The data was published by the Saudi General Statistics Authority. The researcher used the ARDL co-integration model to determine the impact of technological development (GT), industrial labor(GL), and industrial capital (GK) on the output of the industrial sector in Saudi Arabia(GQ).This research included two parts. The first part discussed the technological development and output of the industrial sector in Saudi Arabia during the research period. The second part was devoted to identifying and evaluating the standard research model using the E-views9 program. The results were as follows: The results showed a co-integration relationship between the variables, which means a long-run relationship and a balanced relationship. The results also revealed a positive and important impact of technological development (GT) on the output of the industrial sector in Saudi Arabia. The results of a long-run relationship were as follows: An increase in technological development (GT) by one unit leads to an increase in output in the industrial sector (GQ) by (0.33), and the relationship between them is positive and significant. While increasing in spending on industrial workers (GL) by one unit leads to an increase in the output in the industrial sector (GQ) by (-28.18), and the relationship between them is negative and not significant. Also increasing in industrial capital spending (GK) by one unit leads to an increase in the output in the industrial sector (GQ) by (-3.88), and the relationship between them is negative and not significant. The results of a short-run relationship showed that there is a positive and significant relationship between the output of the industrial sector and technological development (GT), and a negative and non-significant relationship between the output of the industrial sector and both spending on industrial workers (GL) and spending on industrial capital (GK). We also note that the value of the error correction factor (CointEq- 1) was (-0.89), which is a negative and significant value at (5%). This indicates the existence of a valid Co-integration relationship and that the deviations in the short-run are corrected with (-0.89), to reach a long-run equilibrium relationship.

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